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Web based education on energy efficient appliances in Romania

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Abstract — Manufacturers have developed a new generation of household appliances which perform their functions more effectively and use less resources like energy and water. The next step is to inform and educate students and their families how using appliances more efficiently can help to reduce greenhouse gas emissions and prevent climate change. An on-line resource has developed (www.eais.info) as an enlarged appliance database accessible via Internet, a home appliance energy survey which is downloadable from the website, modules which explain the origins and impacts of global warming, product, labeling and energy saving in the home through using appliances more efficiently and a set of activities together with resource material suitable for use in primary and secondary schools throughout Romania (an eBook).

Keywords — appliances database, eBook, energy efficiency, energy saving, labelling.

I. INTRODUCTION

Appliance usage is increasing within the EU 25 Member States as living standards rise and manufacturers produce more household appliances. EU citizens now spend some 15 billion euros per year on buying appliances and 8 billion euros on operating them. The electricity consumed by appliances amounts to more than 100 TWh per year which results in more than 50 million tonnes of carbon dioxide emissions to the atmosphere. The only way that this increased energy consumption can be contained is if the energy consumption per appliance can be *decreased* and appliances used more efficiently.

The potential for saving energy and resources, reducing pollution and preventing climate change is therefore very large. Energy resources will have to be used in a more sustainable way to reduce resource depletion and environmental pollution which can lead to global warming and climate change. The first step in realising this

potential is information and education. Suitable on-line resources have therefore been developed for use in educating both students and their families. The emphasis has been on saving energy by the more efficient use of existing household appliances and the purchase of more energy efficient models when these appliances have to be replaced.

II. EDUCATIONAL RESOURCES FOR SCHOOLS

A. Introduction

The school is the most important source of information and therefore crucial in raising awareness in families, as occurred when campaigns were initiated in the 1980's to introduce lead free petrol. The introduction of product labelling like the EU energy label has allowed products to be identified which are more energy efficient and perform better. Consequently Internet based resources for teachers and students have been developed which discuss the reasons for saving energy and also how energy can be saved through a series of practical activities.

B. Developing the resources

Practical activities have been developed to explain and illustrate one or more of the key themes of energy usage and savings in the home as shown in Table 1.

Table 1: Activity themes

What is energy
Electrical energy sources
Greenhouse effect
Kyoto protocols
Energy savings in the home
Energy usage in the home
Using efficient energy appliances

These activities were then trialled in various types of schools with students of a range of ages and abilities, using the eBook available on Internet. Activities are suitable for both primary and secondary schools and can be given in any appropriate class, and in any type or size of school.

C. The teaching methodology

The methodology has been developed and is described briefly below.

Activities

Activities are planned to be the core elements of the lessons. Every lesson should include one or more activities. For each activity there is:

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- resource material providing background information for introducing the subject
- work sheets for students (downloadable from Internet)
- notes for teachers

Age range

- from age 7 to 16
- understanding the importance of energy use
- understanding the issues associated with climate change
- explaining and involving their parents
- considering how appliances are used in the home
- understanding where energy can be saved

Working in small groups

- discussing and helping one another
- exchanging information
- easier for teacher to supervise

Role of the teacher

- introducing the topics using the Internet
- helping the groups
- discussing the outputs with the pupils
- summarising and evaluating the results

D. Typical activities

The activities have been developed to stimulate thinking about energy usage and the possible ways of using it more efficiently. Such activities are crosswords, magic rectangle, tests, questions to be answered, etc. Each lesson has an “Advices” part.

E. Trials in schools

One method was to disseminate the elaborated resources to all primary schools. The other method used was to target the schools in a particular region and invite them to take part in a workshop at which the concepts and materials were presented.

Primary schools have been more interested than secondary schools principally because the teachers work with a single class. For secondary schools, the activities cover a range of disciplines and so it is less easy to identify who should teach specific topics.

F. Level of success

The topics are relevant, timely and of interest to both students and teachers. A number of barriers have been identified which will need to be addressed:

- the rearrangement of schedules to find the time to teach the lessons
- the lack of teacher confidence to introduce such broad topics, especially using Internet
- the agreement and encouragement of head teachers and local education authorities for teachers wishing to teach these topics
- the integration of the topics and activities into existing lesson plans

Ideally, every student should be introduced to these topics at least once in primary school and again in secondary school. Not only would their understanding be

enhanced, but also the concept of individual behaviour having global implications would be reinforced.

III. INFORMATION RESOURCES FOR FAMILIES

A. Introduction

It is important to raise awareness of the potential for saving energy in the home amongst parents as well as students. For them, additional information is required and in a different format.

The following resources have been developed:

- an appliance energy survey in the form of a spreadsheet downloadable from the EAIS website which can be used to quantify the potential savings due to appliance use
- information on how to reduce domestic electricity bills
- an updated appliance database with a suitable set of search criteria for each EU labelled product group

B. The electricity bill

The starting point of any survey is to examine the electricity bill and how energy consumption and tariffs are interrelated. Due to the high level of electricity price, there is a better incentive to encourage energy savings.

Electricity bills including room and water heating are more difficult to interpret as these appliances have not yet been energy labelled. In addition, the heat loss of the dwelling is not considered within these resources. Thus the survey has concentrated on those appliances which are energy labelled as the potential savings can be quantified.

C. A virtual tour of the home

To understand in a qualitative way where energy is being used, a virtual tour of the home has been developed. Four typical rooms are illustrated; a living room, kitchen, bathroom and a bedroom. For each room there is an indication of the likely energy consumption of each appliance in the room and the possible savings if the best available technology was used. This allows a comparison of consumption between appliances and identification of the largest electricity user. After summing up the various contributions, the estimated consumption can be compared with the actual consumption on the bill.

If the measured consumption is much larger than the estimate, this could indicate a faulty appliance and the user is encouraged to investigate further. The other way to reduce energy consumption is to use appliances more efficiently and a series of suggestions have been assembled for each of the major appliance groups.

D. Appliance energy survey

Considerable thought was given to a form that was easy to complete. A spreadsheet seemed the best way because it was possible to calculate both the likely energy consumption and the potential savings. This is an activity that can involve students as well as parents as the students are able to use computer software.

The most detailed information is required for *lamps* for which the lamp type, power rating and average number of

hours usage per day is required. The *water heater* efficiency is based on the age of the boiler and the number of people in the family (table 4.1). For *white goods* such as fridges, freezers, washing machines and dishwashers, the efficiency is based on age, and either height (equivalent to volume) or number of cycles per month. For *leisure/electronic appliances*, the number of hours of usage, screen width (if relevant) and use of remote control are important.

For *cooking*, only the oven or microwave usage is considered; for heating and cooling the number of hours of use per month.

Table 2: Appliance energy survey – water heating

ELECTRIC WATER HEATERS				
		MONTHLY ESTIMATED CONSUMPTION (kWh)	MONTHLY SAVINGS (kWh)	SAVINGS AS PERCENTAGE OF CONSUMPTION
HEATER 1				
Do you have an electrical water heater (If Yes, fill in):				
Number of people using it				
Age of the heater (years)				
Capacity (litres)				
HEATER 2				
Do you have an electrical water heater (If Yes, fill in):				
Number of people using it				
Age of the heater (years)				
Capacity (litres)				

The survey calculates the energy consumption based on information entered by the family and can be completed on or off-line. The program then calculates the potential savings for each appliance group for a typical month. By this means it is possible not only to identify the appliances using the most energy, but also which group has the highest savings potential household as calculated by the survey.

Table 3: Monthly usage and savings of a typical household as calculated by the survey

Consumption	Usage	savings KWh
Lighting	65	20
Cold appliances	69	24
Washing	55	17
Cooking	28	13
Home electronics	27	13
Water heating	55	0
Space heating	0	0
Other uses	53	8
Total	352	95

Analysis of the completed surveys allows the following conclusions to be made:

- the survey can estimate the consumption quite accurately if time is taken to fill in the form correctly
- wide variation in usage reflecting family size, occupancy, age and appliance use
- potential energy savings is not directly related to energy consumption
- the nature of the possible savings varies in each household (table 4.3)
- statistical data on appliance use and age and on the use of low energy light bulbs

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E. Potential for appliance energy savings

The potential energy savings as analysed by replies to the survey 33% for Romania, where average electricity usage/year is 2,400 kWh and average potential energy savings are 800 kWh. .

Households in the EU 25 consume more than 100 TWh per year. If one assumes a similar savings potential for the other states, then the potential appliance savings for the EU 25 could be as high as **34 TWh per year** resulting in a reduction of 17 million tonnes of CO2 per year. These savings are achievable using products that already exist and do *not* require any further improvements in technology.

IV. THE EAIS APPLICATION

A. Short presentation of the EAIS application

EAIS is a web-based application, part-funded by the EU SAVE Programmes 99/043 and 02/055, implemented with the goal of enabling European citizens to access, via the Internet, energy and performance information for 12 household appliances sold in 9 European countries. The realization of the EAIS application represents a major step in transforming the market for energy efficient household appliances, which was initiated when EU approved the energy framework labelling directive in 1992. The system is based on information contained within the Energy Label and its associated Fiche.

The main goals of EAIS system are:

- To link energy use with the environmental pollution.
- To inform and educate citizens, energy advisers and students about the potential for saving energy in the home with appliances.
- To assist consumers to purchase appliances which will save energy, money and environment.
- To assist retailers in complying with existing EU legislation concerning energy labelling.
- To assist manufacturers in informing the public of the wide range of energy efficient appliances available.
- To assist the EU meet its commitments under the Kyoto convention on greenhouse gas emissions

B. EAIS architecture

The three-layered architecture was chosen. The

presentation layer assumes that the user only needs a web browser to access all applications provided within the system. The second layer encompasses the server layer – both www server preparing documents for the presentation layer and server realizing authentication, authorization and ensuring integration with data layer. The data layer is a repository of all kinds of data gathered by the EAIS system. The database are included in the third layer.

EAIS is designed to perform the data supply and application layer onto the server side in the backend. Only the presentation is left over to the client computer. The clients will use a traditional web browser requesting the dynamic ASP pages over the server.

The server is a standard Compaq PC (800 MHz, 20Gb, 512 Mb). The software used is Windows 2000 as operating system and SQL Server 2000 as DBMS to develop the EAIS database [1], [2]. The interface was developed in Macromedia Dreamweaver, Java script and ASP (Active Server Pages).

The EAIS architecture contains a firewall (who processes every network request for server, ensuring the system with a higher security level and also protecting the database). The EAIS web server Internet interface consists of a dual-homed firewall, which is a PC computer running Slackware Linux 8.0 with updates. It is an Intel Pentium 120Mhz with 32Mb RAM and 1Gb HDD. It has 2 network cards: one connected to the Internet side (ICI network), one connected to the internal network side (EAIS WWW server).

The EAIS database content is the following:

- All white goods appliances currently stocked by the manufacturers or by the retailers in each country which are or will be energy labelled by EU.
- All energy efficient models (A-C) manufactured by the suppliers of each country.
- Consumer electronics and office equipment.
- Appliance groups which have recently been labelled such as ovens, lamps and room air conditioners.

Each appliance type and model has a set of information extracted from the EU energy label and information fiche, which provides information which enables one to characterise a particular appliance model and to compare with other model. The following information is generally supplied:

- Energy efficiency rating on an A to G scale with A being the most efficient and G the least efficient: for cold appliances two more ratings have been added above the A rating, A+ and A++ which is the most efficient energy rating.
- Energy consumption per year (or cycle).
- Water consumption per cycle.
- Volume or capacity.
- Other performance criteria like washing or drying capability.
- Noise emissions (voluntary).

The information fiche contains the information on the label as well as additional information on the performance of the appliance generally for different usage cycles and must be shown to you at point of sale. The EU ecolabel is an environmental label which considers the environmental impact of a product's manufacture, usage and recycling. Unlike the EU energy label it is a voluntary label and so if it is not present one cannot be certain whether the manufacturer has applied to attach the label or not. The energy star and GEA labels are used in home office equipment and consumer electronics respectively and set a maximum value for energy consumption when the appliance is not in use or in stand-by mode.

The European appliance information system now provides a wide variety of information which can be used to identify where energy can be saved in the home. It also provides practical suggestions as to how energy can be saved by better use of existing appliances or when purchasing a new appliance having a lower environmental impact than that being replaced.

The website serves the dual functions of informing and educating persons how the energy consumed in the home can be used more efficiently.

C. Main EAIS database functions

Selecting energy efficient appliances

The EU label and fiche allows one to select a model in terms of its characteristics such as size or volume, performance, energy and water usage. This information is stored in a database which can be consulted once you have defined your specific needs.

The search mechanism in the database is perhaps the most useful service [3].

Searching can use one or more of the following criteria:

- *Appliance selection criteria in terms of:* Type, Size, Performance and Price Range. These parameters narrow the resulting set of appliances. Some useful hints help the user and assist selection.
- *Manufacturer:* useful when searching for the whole group of an appliance of one manufacturer.
- *Product name:* used when searching for a specific appliance.

Database outputs

Based on the searching parameters, the search mechanism generates a list of matching appliances along with all the national data set that is stored in the EAIS database. When searching, a page is displayed containing useful environmental information. The consumer is informed that buying energy efficient appliances not only saves energy and money, but will also helps to reduce environmental pollution.

The search output is listed in tabular form containing groups of 5 products plus the typical 10 years old model. For each appliance the following general information is provided:

- Manufacturer/Model.
- Size.
- Energy Efficiency Class.
- Energy Consumption and some specific

information characterizing a group of appliances.

Lifetime operating cost

The lifetime cost is calculated based on usage of electricity, water and detergent (where applicable) and compared with the operating cost of a typical 10 year old appliance. This indicates how much energy and money you can save with a new appliance and what contribution this will reduce greenhouse gas emissions. This module is perhaps the most important of the system because it offers information about the energy efficiency of the appliance based on a 15 years lifetime [4], [5].

The lifetime operating cost consists of the amount of electricity, water and detergent used over the lifetime of the appliance (Figure 1).



Figure 1: Lifetime cost calculation

Energy efficient appliances have a lower running cost because they consume less electricity, water and detergent. The cost calculator determines the lifetime cost and the savings when comparing an older model with any model selected from the appliance database.

V. CONCLUSIONS

The potential for energy savings through more efficient use of appliances is very high and the web-based application presented in this paper can assist in realizing this potential through making available resources which can help individual families to identify where energy is being used and how it can be saved. Through developing and trialling suitable resources for students (a web-based application and an eBook), it will also be possible to educate them in both the nature of the problem and also the possible methods of using appliances more efficiently. This information is now available via a website at www.eais.info.

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